INSTRUCTION MANUAL

HMP50 Temperature and Relative Humidity Probe

Revision: 10/09

Warranty and Assistance

The **HMP50 TEMPERATURE AND RELATIVE HUMIDITY PROBE** is warranted by CAMPBELL SCIENTIFIC, INC. to be free from defects in materials and workmanship under normal use and service for twelve (12) months from date of shipment unless specified otherwise. Batteries have no warranty. CAMPBELL SCIENTIFIC, INC.'s obligation under this warranty is limited to repairing or replacing (at CAMPBELL SCIENTIFIC, INC.'s option) defective products. The customer shall assume all costs of removing, reinstalling, and shipping defective products to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return such products by surface carrier prepaid. This warranty shall not apply to any CAMPBELL SCIENTIFIC, INC. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. CAMPBELL SCIENTIFIC, INC. is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. The following contact information is for US and International customers residing in countries served by Campbell Scientific, Inc. directly. Affiliate companies handle repairs for customers within their territories. Please visit www.campbellsci.com to determine which Campbell Scientific company serves your country.

To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (435) 753-2342. After an applications engineer determines the nature of the problem, an RMA number will be issued. Please write this number clearly on the outside of the shipping container. CAMPBELL SCIENTIFIC's shipping address is:

CAMPBELL SCIENTIFIC, INC.
RMA#_____
815 West 1800 North
Logan, Utah 84321-1784

For all returns, the customer must fill out a "Declaration of Hazardous Material and Decontamination" form and comply with the requirements specified in it. The form is available from our website at www.campbellsci.com/repair. A completed form must be either emailed to repair@campbellsci.com or faxed to 435-750-9579. Campbell Scientific will not process any returns until we receive this form. If the form is not received within three days of product receipt or is incomplete, the product will be returned to the customer at the customer's expense. Campbell Scientific reserves the right to refuse service on products that were exposed to contaminants that may cause health or safety concerns for our employees.

HMP50 Table of Contents

PDF viewers note: These page numbers refer to the printed version of this document. Use the Adobe Acrobat® bookmarks tab for links to specific sections.

Figures

Tables

HMP50 Temperature and Relative Humidity Probe

1. General

The HMP50 Temperature and Relative Humidity probe contains a Platinum Resistance Temperature detector (PRT) and a Vaisala INTERCAP® capacitive relative humidity sensor.

The -L option on the model HMP50 Temperature and Relative Humidity probe (HMP50-L) indicates that the cable length is user specified. Lead length is specified when the sensor is ordered. Table 1 gives the recommended lead length. This manual refers to the sensor as the HMP50.

TABLE 1. Recommended Lead Lengths

2 m Height		Atop a tripod or tower via a 2 ft crossarm such as the CM202							
Mast/Leg	**CM202**	**CM6**	**CM10**	**CM110**	**CM115**	**CM120**	**UT10**	**UT20**	**UT30**
9'	11'	11'	14'	14'	19'	24'	14'	24'	37'

Note: *Add two feet to the cable length if you are mounting the enclosure on the leg base of a light-weight tripod.*

2. Specifications

Operating Temperature: -40°C to +60°C

Storage Temperature: -40°C to +80°C

Probe Length: 7.1 cm (2.8 in.)

Probe Body Diameter: 1.2 cm (0.47 in.)

Filter: 0.2 µm Teflon membrane

Filter Diameter: 1.2 cm (0.47 in.)

Housing Material: chrome-coated aluminum and chrome-coated ABS plastic

Power Consumption: <2 mA

Supply Voltage: 7 to 28 VDC

Settling Time after power is switched on: 1 second

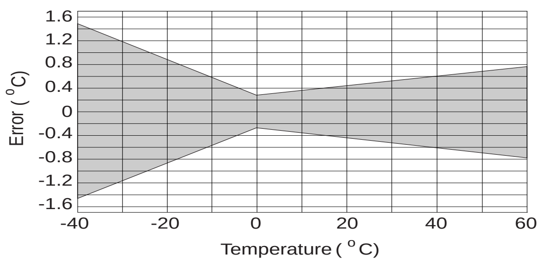
2.1 Temperature Sensor

Sensor: 1000 Ω PRT, DIN 43760B

Temperature Measurement Range: -40°C to +60°C

Temperature Output Signal range: 0 to 1.0 VDC

Temperature Accuracy:



2.2 Relative Humidity Sensor

Sensor: INTERCAP®

Relative Humidity Measurement Range: 0 to 98% non-condensing

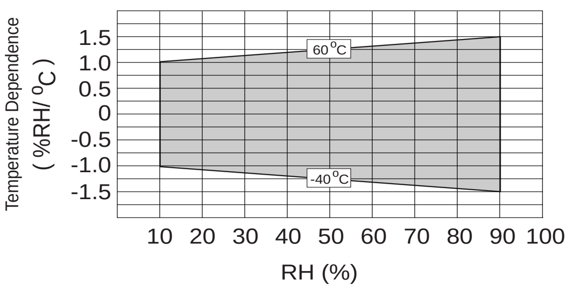
RH Output Signal Range: 0 to 1.0 VDC

Accuracy at 20°C

±3% RH (0 to 90% Relative Humidity)

±5% RH (90 to 98% Relative Humidity)

Temperature Dependence of Relative Humidity Measurement:



Typical Long Term Stability: Better than 1% RH per year

Response Time (at 20°C, 90% response to a steep change in humidity):

15 seconds with membrane filter

3. Installation

3.1 Siting

Sensors should be located over an open level area at least 9 m (EPA) in diameter. The surface should be covered by short grass, or where grass does not grow, the natural earth surface. Sensors should be located at a distance of at least four times the height of any nearby obstruction, and at least 30 m (EPA) from large paved areas. Sensors should be protected from thermal radiation, and adequately ventilated.

Standard measurement heights:

1.5 m +/- 1.0 m (AASC)
1.25 – 2.0 m (WMO)
2.0 m (EPA)
2.0 m and 10.0 m temperature difference (EPA)

See Section 9 for a list of references that discuss temperature and relative humidity sensors.

3.2 Mounting and Assembly

Pull off the yellow shipping cap (see Figure 1).

The HMP50 must be housed inside a solar radiation shield when used in the field. The 41303-5A 6-Plate Radiation Shield (Figures 2 and 3) mounts to a tripod mast, UT10 tower leg, or CM202, CM204, or CM206 crossarm. The HMP50 is held within the 41303-5A by a mounting clamp (Figure 3).

The UT6P 6-plate Radiation Shield mounts to a UT10, UT20, or UT30 tower with the UT018 horizontal mounting arm.

NOTE The black outer jacket of the cable is Santoprene® rubber. This compound was chosen for its resistance to temperature extremes, moisture, and UV degradation. However, this jacket will support combustion in air. It is rated as slow burning when tested according to U.L. 94 H.B. and will pass FMVSS302. Local fire codes may preclude its use inside buildings.

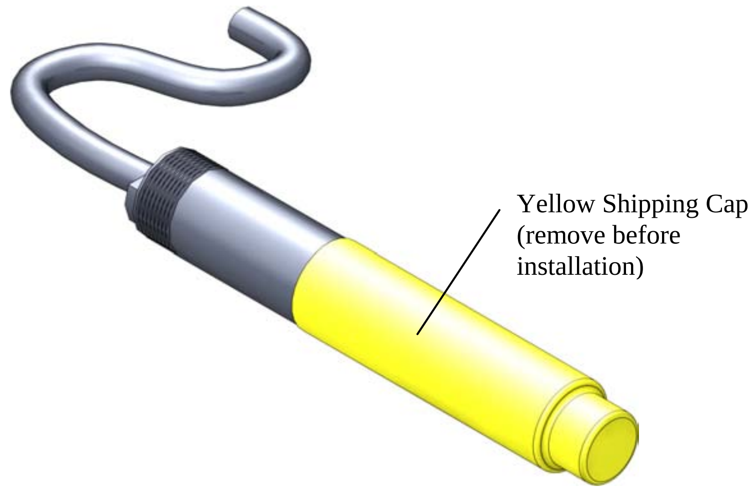


FIGURE 1. HMP50 as Shipped

FIGURE 2. HMP50 and 41303-5A Radiation Shield on a Tripod Mast

FIGURE 3. HMP50 and 41303-5A Radiation Shield on a CM202 Crossarm

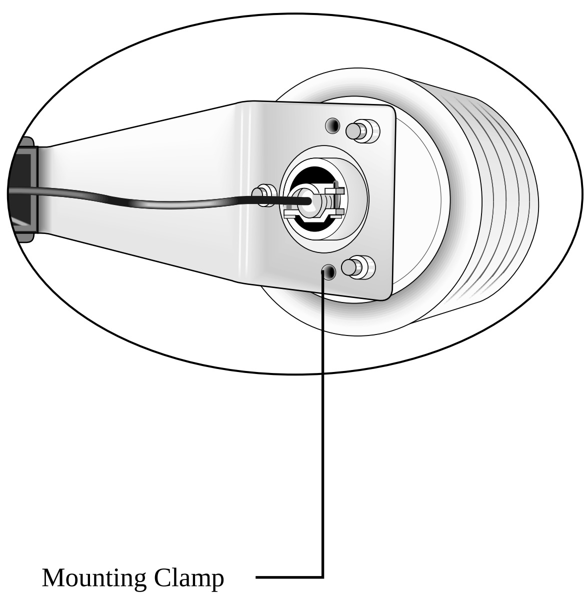


FIGURE 4. HMP50 and 41303-5A Radiation Shield

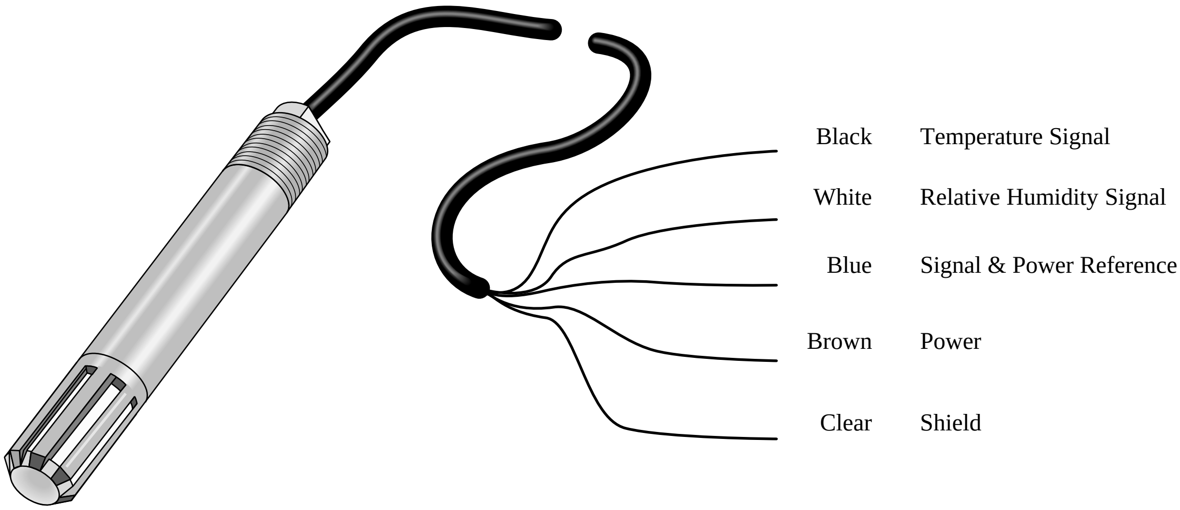


FIGURE 5. HMP50 Wiring

TABLE 2. Datalogger Connections

Wire Label	Color	CR800, CR3000, CR200, CR23X, CR1000	CR10(X), CR510	21X, CR7
Temp Signal	Black	Single-Ended Input	Single-Ended Input	Single-Ended Input
RH Signal	White	Single-Ended Input	Single-Ended Input	Single-Ended Input
Power & Signal Ground	Blue	G	G	⏚
Power 12V	Brown	12 V	12 V	12 V
Shield	Clear	⏚	G	⏚

4. Wiring

Connections to Campbell Scientific dataloggers are given in Table 2. The probe is measured by two single-ended analog input channels, one for temperature and one for relative humidity.

CAUTION Always connect the Blue lead to the datalogger first, followed by the Black, White, and Clear leads. Connect the Brown (Power) lead last.

5. Example Programs

This section is for users who write their own datalogger programs. A datalogger program to measure this sensor can be created using Campbell Scientific's Short Cut Program Builder Software. You do not need to read this section to use Short Cut.

The temperature and relative humidity signals from the HMP50 are measured using two single-ended analog measurements (Instruction 1).

The probe output scale is 0 to 1000 millivolts for the temperature range of -40°C to +60°C and for the relative humidity range of 0 to 100%. Tables 3 and 4 provide calibration information for temperature and relative humidity.

TABLE 3. Calibration for Temperature

Units	Multiplier (degrees mV^{-1})	Offset (degrees)
Celsius	0.1	-40
Fahrenheit	0.18	-40

TABLE 4. Calibration for Relative Humidity

Units	Multiplier (% mV^{-1})	Offset (%)
Percent	0.1	0
Fraction	0.001	0

TABLE 5. Wiring for CR1000 and CR10X Examples

Description	Color	CR1000	CR10(X)
Temperature	Black	SE 1	SE 3 (2H)
Relative Humidity	White	SE 2	SE 4 (2L)
Signal & Power Reference	Blue	G	G
Power	Brown	12 V	12 V
Shield	Clear	⏚	G

5.1 Example for CR1000

```
'CR1000
'Created by SCWIN (2.1)

Public AirTC
Public RH

DataTable(Table1,True,-1)
	DataInterval(0,60,Min,0)
	Average(1,AirTC,FP2,0)
	Sample(1,RH,FP2)
EndTable
```

```
BeginProg
    Scan(5,Sec,1,0)
        'HMP50 Temperature & Relative Humidity Sensor measurements AirTC and RH:
        VoltSE(AirTC,1,mV2500,1,0,0,_60Hz,0.1,-40.0)
        VoltSE(RH,1,mV2500,2,0,0,_60Hz,0.1,0)
        If (RH>100) And (RH<108) Then RH=100
        CallTable(Table1)
    NextScan
EndProg
```

5.2 Example for CR10X

```
;Measure the HMP50 temperature.
;
01:  Volt (SE) (P1)
  1:   1            Reps
  2:   5            2500 mV Slow Range        ;CR510 (2500 mV); CR23X (1000 mV); 21X,
                                              CR7 (5000 mV)
  3:   3            SE Channel                ;Black wire (SE 3), Blue wire (G)
  4:   1            Loc [ T_C      ]
  5:   .1           Mult                      ;See Table 3 for alternate multipliers
  6:   -40          Offset                    ;See Table 3 for alternate offsets

;Measure the HMP50 relative humidity.
;
02:  Volt (SE) (P1)
  1:   1            Reps
  2:   5            2500 mV Slow Range        ;CR510 (2500 mV); CR23X (1000 mV); 21X,
                                              CR7 (5000 mV)
  3:   4            SE Channel                ;White wire (SE 4), Blue wire (G)
  4:   3            Loc [ RH_pct   ]
  5:   .1           Mult                      ;See Table 4 for alternate multipliers
  6:   0            Offset

;Limit the maximum relative humidity to 100%.
;
03:  If (X<=>F) (P89)
  1:   3            X Loc [ RH_pct   ]
  2:   3            >=
  3:   100          F
  4:   30           Then Do

04:  Z=F (P30)
  1:   100          F
  2:   0            Exponent of 10
  3:   3            Z Loc [ RH_pct   ]

05:  End (P95)
```

6. Long Lead Lengths

Long lead lengths cause errors in the measured temperature and relative humidity. The approximate error in temperature and relative humidity is 0.52°C and 0.52% per 100 feet of cable length, respectively.

When long lead lengths are required and the above errors in temperature and relative humidity are unacceptable, use the HMP45C temperature and humidity probe.

Understanding the following details are not required for the general operation of the HMP50 with Campbell Scientific's dataloggers. The signal reference and the power ground (black) are the same lead in the HMP50. When the HMP50 temperature and relative humidity are measured, both the signal reference and power ground are connected to ground at the datalogger. The signal reference/power ground lead serves as the return path for 12 V. There will be a voltage drop along this lead because the wire itself has resistance. The HMP50 draws approximately 2 mA when it is powered. The wire used in the HMP50 (P/N 18159) has resistance of 26.2 Ω/1000 feet. Using Ohm's law, the voltage drop (V_d), along the signal reference/power ground lead, is given by Eq. (1).

$$\begin{aligned} V_d &= I * R \\ &= 2\,\text{mA} * 26.2\,\Omega / 1000\,\text{ft} \\ &= 52.4\,\text{mV} / 1000\,\text{ft} \end{aligned} \tag{1}$$

This voltage drop will raise the apparent temperature and relative humidity because the difference between the signal and signal reference, at the datalogger, has increased by V_d. The approximate error in temperature and relative humidity is 0.35°C and 0.35% per 100 feet of cable length, respectively.

7. Absolute Humidity

The HMP50 measures the relative humidity. Relative humidity is defined by the equation below:

$$\text{RH} = \frac{e}{e_s} * 100 \tag{2}$$

where RH is the relative humidity, e is the vapor pressure in kPa , and e_s is the saturation vapor pressure in kPa. The vapor pressure, e, is an absolute measure of the amount of water vapor in the air and is related to the dew point temperature. The saturation vapor pressure is the maximum amount of water vapor that air can hold at a given air temperature. The relationship between dew point and vapor pressure, and air temperature and saturation vapor pressure are given by Goff and Gratch (1946), Lowe (1977), and Weiss (1977).

When the air temperature increases, so does the saturation vapor pressure. Conversely, a decrease in air temperature causes a corresponding decrease in saturation vapor pressure. It follows then from Eq. (2) that a change in air temperature will change the relative humidity, without causing a change in absolute humidity.

For example, for an air temperature of 20°C and a vapor pressure of 1.17 kPa, the saturation vapor pressure is 2.34 kPa and the relative humidity is 50%. If the air temperature is increased by 5°C and no moisture is added or removed from the air, the saturation vapor pressure increases to 3.17 kPa and the relative humidity decreases to 36.9%. After the increase in air temperature, there is more energy available to vaporize the water. However, the actual amount of water vapor in the air has not changed. Thus, the amount of water vapor in the air, relative to saturation, has decreased.

Because of the inverse relationship between relative humidity and air temperature, finding the mean relative humidity is meaningless. A more useful quantity is the mean vapor pressure. The mean vapor pressure can be computed on-line by the datalogger. CRBasic dataloggers use the VaporPressure instruction to calculate vapor pressure from temperature and relative humidity measurements (see Section 7.1). Edlog dataloggers must first calculate the saturation vapor pressure and then calculate vapor pressure (see Section 7.2).

TABLE 6. Wiring for Vapor Pressure Examples

Description	Color	CR10(X)	CR1000
Temperature	Black	SE 3 (2H)	SE 1 (1H)
Relative Humidity	White	SE 4 (2L)	SE 2 (2H)
Signal & Power Reference	Blue	G	G
Power	Brown	12 V	12 V
Shield	Clear	G	⏚

7.1 CR1000 Vapor Pressure Example

The VaporPressure instruction has the following syntax:

VaporPressure (Dest, Temp, RH)

Where:

Dest—the variable in which the results of the instruction will be stored.

Temp—the program variable that contains the value for the temperature sensor. The temperature measurement must be in degrees C.

RH—the program variable that contains the value for the relative humidity sensor. The RH measurement must be in percent of RH.

```
'CR1000

Public AirTC
Public RH
Public VP

DataTable(Table1,True,-1)
    DataInterval(0,60,Min,0)
    Average(1,AirTC,FP2,0)
    Sample(1,RH,FP2)
    Average(1,VP, FP2,0)
EndTable

BeginProg
    Scan(5,Sec,1,0)
        'HMP50 Temperature & Relative Humidity Sensor measurements AirTC and RH:
        VoltSE(AirTC,1,mV2500,1,0,0,_60Hz,0.1,-40.0)
        VoltSE(RH,1,mV2500,2,0,0,_60Hz,0.1,0)
        If (RH>100) And (RH<108) Then RH=100
        VaporPressure(VP,AirTC,RH)
        CallTable(Table1)
    NextScan
EndProg
```

7.2 Sample CR10(X) Program that Computes Vapor Pressure and Saturation Vapor Pressure

```
;Measure the HMP50 temperature.
;
01:  Volt (SE) (P1)
  1:   1          Reps
  2:   5          2500 mV Slow Range     ;CR510 (2500 mV); CR23X (1000 mV); 21X,
                                         CR7 (5000 mV)
  3:   3          SE Channel             ;Black wire (SE 3), Blue wire (G)
  4:   1          Loc [ T_C       ]
  5:   .1         Mult                   ;See Table 3 for alternate multipliers
  6:   -40        Offset                 ;See Table 3 for alternate offsets

;Measure the HMP50 relative humidity.
;
02:  Volt (SE) (P1)
  1:   1          Reps
  2:   5          2500 mV Slow Range     ;CR510 (2500 mV); CR23X (1000 mV); 21X,
                                         CR7 (5000 mV)
  3:   4          SE Channel             ;White wire (SE 4), Blue wire (G)
  4:   2          Loc [ RH_frac   ]
  5:   .001       Mult                   ;See Table 4 for alternate multipliers
  6:   0          Offset
```

```
;Limit the maximum value of relative humidity
;to 1 (expressed as a fraction).
;
03:  If (X<=>F) (P89)
   1:    2                  X Loc [ RH_frac   ]
   2:    3                  >=
   3:    1                  F
   4:    30                 Then Do

04:  Z=F (P30)
   1:    1                  F
   2:    0                  Exponent of 10
   3:    2                  Z Loc [ RH_frac   ]

05:  End (P95)

;Compute the saturation vapor pressure in kPa.
;The temperature must be in degrees Celsius.
;
06:  Saturation Vapor Pressure (P56)
   1:    1                  Temperature Loc [ T_C       ]
   2:    3                  Loc [ e_sat     ]

;Compute the vapor pressure in kPa.
;Relative humidity must be a fraction.
;
07:  Z=X*Y (P36)
   1:    3                  X Loc [ e_sat     ]
   2:    2                  Y Loc [ RH_frac   ]
   3:    4                  Z Loc [ e         ]
```

8. Maintenance

The HMP50 Probe requires minimal maintenance. Check monthly to make sure the radiation shield is free from debris. The white screen at the tip of the probe should also be checked for contaminants.

When installed in close proximity to the ocean or other bodies of salt water (e.g., Great Salt Lake), a coating of salt (mostly NaCl) may build up on the radiation shield, sensor, filter and even the chip. NaCl has an affinity for water. The humidity over a saturated NaCl solution is 75%. A buildup of salt on the filter or chip will delay or destroy the response to atmospheric humidity.

The filter can be rinsed gently in distilled water. If necessary, the chip can be removed and rinsed as well (see Figure 6 and Section 8.1). Do not scratch the silver chip while cleaning. It might be necessary to repeat rinsing.

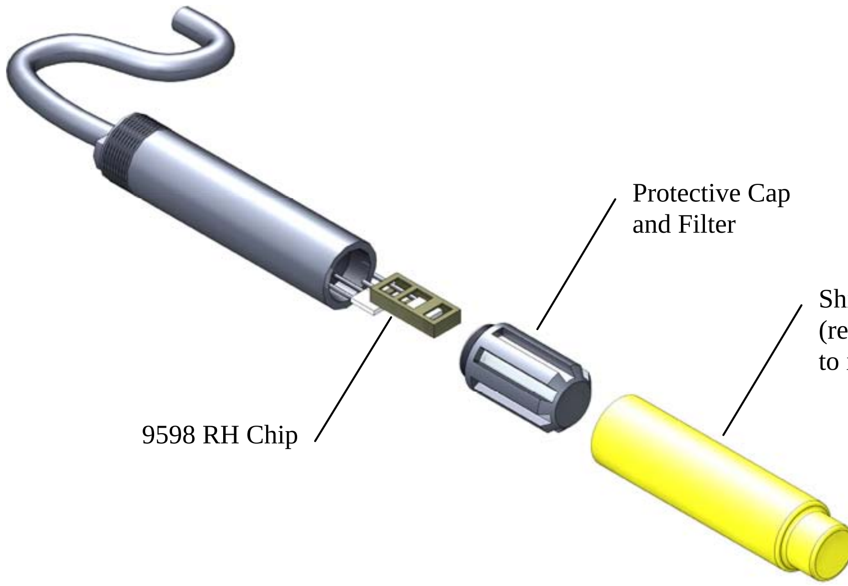


FIGURE 6. Exploded View of HMP50 (as shipped)

The offset and gain on the HMP50 electronics can not be adjusted as part of a recalibration. Replace the RH chip as needed.

8.1 Procedure for Removing RH Chip

1. Unscrew the protective cap.

2. Hold the plastic sides of the RH chip and unplug it.

CAUTION To prevent scratching, avoid touching the silver RH chip, and handle the RH chip with care.

3. Rinse the RH chip or dispose of the old RH chip.

4. Hold the sides of the rinsed or new chip and plug it in.

5. Screw on the protective cap.

9. References

Goff, J. A. and S. Gratch, 1946: Low-pressure properties of water from -160° to 212°F, *Trans. Amer. Soc. Heat. Vent. Eng.*, **51**, 125-164.

Lowe, P. R., 1977: An approximating polynomial for the computation of saturation vapor pressure, *J. Appl. Meteor.*, **16**, 100-103.

Weiss, A., 1977: Algorithms for the calculation of moist air properties on a hand calculator, *Amer. Soc. Ag. Eng.*, **20**, 1133-1136.

Campbell Scientific Companies

Campbell Scientific, Inc. (CSI)
815 West 1800 North
Logan, Utah 84321
UNITED STATES
www.campbellsci.com • info@campbellsci.com

Campbell Scientific Africa Pty. Ltd. (CSAf)
PO Box 2450
Somerset West 7129
SOUTH AFRICA
www.csafrica.co.za • cleroux@csafrica.co.za

Campbell Scientific Australia Pty. Ltd. (CSA)
PO Box 444
Thuringowa Central
QLD 4812 AUSTRALIA
www.campbellsci.com.au • info@campbellsci.com.au

Campbell Scientific do Brazil Ltda. (CSB)
Rua Luisa Crapsi Orsi, 15 Butantã
CEP: 005543-000 São Paulo SP BRAZIL
www.campbellsci.com.br • suporte@campbellsci.com.br

Campbell Scientific Canada Corp. (CSC)
11564 - 149th Street NW
Edmonton, Alberta T5M 1W7
CANADA
www.campbellsci.ca • dataloggers@campbellsci.ca

Campbell Scientific Centro Caribe S.A. (CSCC)
300 N Cementerio, Edificio Breller
Santo Domingo, Heredia 40305
COSTA RICA
www.campbellsci.cc • info@campbellsci.cc

Campbell Scientific Ltd. (CSL)
Campbell Park
80 Hathern Road
Shepshed, Loughborough LE12 9GX
UNITED KINGDOM
www.campbellsci.co.uk • sales@campbellsci.co.uk

Campbell Scientific Ltd. (France)
Miniparc du Verger - Bat. H
1, rue de Terre Neuve - Les Ulis
91967 COURTABOEUF CEDEX
FRANCE
www.campbellsci.fr • info@campbellsci.fr

Campbell Scientific Spain, S. L.
Psg. Font 14, local 8
08013 Barcelona
SPAIN
www.campbellsci.es • info@campbellsci.es

Please visit www.campbellsci.com to obtain contact information for your local US or International representative.